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Sustainable Digital Marketing Model for Nature-Based Tourism Destinations: Can Digital Content and Technology Meet the Expectations of Visitors in Karo Regency?

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Abstract

Global population growth and advances in technological innovation are key characteristics of economic development. Digitalization and increased consumption demand green competitive advantages. Sustainability is a major determinant of tourism competitiveness. Karo is a highland regency dominated by mountainous landscapes and is one of the prime tourism destinations in North Sumatra. However, Wi-Fi services and signal coverage are limited at nature-based tourist attractions, which helps preserve a more natural identity and supports conservation. Each supply chain supports integrated and sustainable activities, and environmentally friendly models are promoted to maintain sustainability. Influencer marketing within the creator economy has grown to support tourism activities, with short video content designed to quickly capture tourists' interest. There is still limited digital content reviewing Karo's tourist attractions, especially given the difficulty of signal reception in nature-based destinations, even though they are close to urban areas, raising questions about whether Karo tourism is being neglected. This study aims to develop a digital model for sustainable tourism in Karo. It offers novelty in examining digital content marketing at nature-based tourism destinations and its impact on tourists' digital satisfaction. Using 243 samples, the results identify an appropriate digital marketing model to achieve digital tourist satisfaction. Potential visitors are predominantly aged 21–30 years, students, and unmarried. They typically travel with friends, seek information about tourist destinations through social media, spend one day at the destination, travel 1–2 times per year, use motorcycles as their main mode of transportation, and prefer nature-based tourism activities (91%). In this study, 91% of the variables are interrelated and have direct effects.

Keywords: Digital Marketing; Sustainable Tourism; Smart Tourism; Technology Readiness; Tourist Satisfaction.

Introduction

Global population growth and advances in technological innovation are characteristics of economic development; digitalization and increased consumption require green competitive advantages [1]. Sustainability is a key determinant of tourism destination competitiveness. Although most tourism destinations have moved toward sustainability through policy approaches, the outcomes vary widely [2]. Karo is a highland regency dominated by mountainous landscapes. Most of Karo Regency consists of nature-based tourism areas such as the Forest Park/Tahura, particularly Mount Sinabung and Mount Sibayak, as well as calderas that make Karo a prime destination in North Sumatra.

Green innovation is a fundamental strategy for governments and tourism destination managers seeking to achieve sustainable and competitive growth [3]. It is important to embrace a holistic approach to tourism that integrates living systems and regenerative tourism, including forest landscape and lakescape tourism [4]. Community readiness to support sustainable development goals determines the effectiveness of affective social media content marketing tools [5]. Good conservation and well-being practices have been shown to generate greater tourist engagement [6]. Forms of tourism misconduct can lead to disinformation in attraction content, idealism, and affective organizational commitment [7]. This is not aligned with nature-based tourism in Karo, which experienced a decline during the researcher's observation period.Monotonous work patterns and digitalization in the workplace have increased the desire to travel [8]. Digital devices play a relevant role during travel activities [9]. Technological transformation continues to develop due to technical and social changes in responding to societal needs [10]. The metaverse phenomenon presents opportunities for exploration, experimentation, and interaction [11]. Technology has been shown to influence tourist behavior in the adoption of smart tourism [12]. The technology gap in supporting tourism facilities should be a concern for destination managers and local governments [13]. The lack of such supporting facilities is one of the main problems of nature-based tourism destinations in Karo.Smart technology is essential, particularly websites as sources of information about tourist attractions [14]. Well-designed websites are filled with relevant informational content [15]. Several influencers are used to attract Generation Z in searching for unique tourism products [16]. This is also supported by smartphone algorithms that prioritize tourism destinations in top search results [17]. It is crucial to develop sustainable ecotourism service systems [18]. This is supported by tourism-friendly community attitudes and social media marketing practices [19]. Government initiatives and local community involvement emerge as the most influential drivers of change in the smart tourism sector [4].Actual access to tourism information is provided through available information signboards [14]. Competitive advantage is required to complement supporting aspects [1]. The quality of tourism destinations through energy-efficient buildings and waste management is one of the main concepts of smart tourism [20]. Tourism waste management is monitored, analyzed, planned, designed, and reorganized to become environmentally friendly [21]. This is done not only to protect the environment but also to control waste [22]. It can not only encourage increased production of natural outputs but also promote carbon emission reductions [23]. In practice, the hiking trails of Mount Sibayak are filled with tourist waste.Digital content marketing involves topic selection, content sourcing, and video summarization [24]. Content can be understood because it is able to shape tourist expressions (reviews, testimonials, complaints) through the forms presented (images, audio, and video) [15]. Informative content provides added value for users [25]. Positive reviews of destinations generate high interest [26]. Organic content displays of tourism products can increase trust without creating an artificial appearance [26]. Influencers who promote environmental sustainability are preferred by tourists [27]. Shared content can support sustainability [26].Influencers play a major role in promoting content on social media [28]. The effectiveness of social media influencers in marketing has attracted tourists [4]. Popular content gains special attention from viewers (tourists) [26]. Even short videos can stimulate travel intentions [29]. Tourists sometimes leave reviews and ratings within the created content [26]. Tourist personalization is determined by the value of the destination they visit [30].Cellular networks and Wi-Fi are essential for creating engaging content in nature-based tourism destinations [26]. These technologies enable connectivity between locations and enhance tourism safety and comfort [31]. Destination managers and governments should provide supporting facilities [32]. The importance of infrastructure is not limited to location, as it can reduce costs and increase visits [33]. The use of technology should expand across various platforms and digital services [34]. Networks can

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stimulate rural areas around tourism destinations toward becoming digital villages [18]. This facilitates connections with ecotourism services, public infrastructure, and transportation, making them safer and more accessible [18].

Segmented product offerings are well received across different classes of tourists [32]. Reasonable and high-quality services are key to tourist satisfaction, especially in nature-based destinations [35]. Local community participation plays an important role in maintaining authenticity, local products, destination image, and tourist satisfaction [36]. Tourism destinations contribute to community welfare; therefore, information should be presented as relevant as possible [37]. Technology-based tour guides offer high representations of tourist satisfaction [38]. Social media provides experiences in the form of learning, emotional engagement, passive entertainment, experiential value, and aesthetic appeal [39]. This encourages satisfied tourists to recommend visits [37]. There is limited content reviewing Karo tourism destinations, especially given the difficulty of signal reception in nature-based areas despite their proximity to urban centers, raising the question of whether Karo tourism is being abandoned. This study aims to model sustainable Karo tourism through digital activities.

Who are the potential tourists visiting Karo Regency based on marketing content on social media? What are tourists' digital perceptions? What are the roles of government and destination managers? To what extent do digital technology and social media content influence tourist satisfaction?

In addressing the problems of Karo tourism, the researchers sought to understand the root causes of the issues, collected data to validate and analyze these problems, and thereby proposed alternative solutions and selected the best course of action. The research outcomes will then be submitted to the Government of Karo Regency for implementation.

Research Methodology

Type, Time, and Location of the Study

Quantitative research is a research method with a more complex level of variation because it examines larger samples; however, it is more systematic in conducting research from beginning to end[46]. This study was conducted at tourism destinations in Karo Regency across six sites: Lake Toba, Lake Lau Kawar, Berastagi City, Sikulikap Waterfall, Sidebu Debu Hot Springs, and Mount Sibayak. The study period was planned from May to November 2025.

Figure 3. Tourism Destinations in Karo Regency
Source: Disbudparekrav Provsu [47]

The population is the actual data of the research or observation object, which may be large, small, or infinite [48]. The population in this study consisted of tourists visiting tourism destinations in Karo Regency aged 15 to 55 years. This age range represents the productive age group and is aligned with the objectives of this study.

The sample size in this study was determined using the formula [49]:

n = Research indicator x α
α = amount of data/sample to be taken
Criterion α:
1. If the number of indicators is <10 then α> 10 data (with a minimum of n = 30)
2. If the number of indicators is > 10 then α <10 data (with a minimum of n = 30)

In this study, 27 indicators were used with a calculation of α = 9. Therefore, the sample size employed was n = 27 × 9 = 243 samples, or 243 tourists visiting tourism destinations in Karo Regency. The sampling technique used was purposive sampling with the following criteria: tourists visiting Karo Regency aged 15–55 years; owning a personal smartphone; being aware of Karo's digital marketing; and having knowledge of the potential and information related to tourism destinations.

Data collection methods included questionnaires, interviews, and field observations. Operational definitions are parameters used to identify and explain research variables. These operational definitions describe each variable used as a research indicator in a detailed and precise manner, including labeling and measurement using an ordinal scale.

Table 1. Operational Definitions of the Study

No	Variable	Indicator Code	Indicator Name	Scale
1	Perceived smart tourism journey	PST1	Destination tourism website/social media (DTW) [14], [15]	1-6
		PST2	Uniqueness of the destination tourism area (DTW) [16], [17].	1-6
		PST3	Online recommendations of the destination tourism area (DTW) [18].	1-6
		PST4	Facility support at the destination tourism area (DTW) [41].	1-6
		PST5	Local community acceptance of tourists at the destination tourism area (DTW) [19], [4]	1-6
2	Perceived smart environment	PSE1	Environmental campaigns at the destination tourism area (DTW) [21]	1-6

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No	Variable	Indicator Code	Indicator Name	Scale
		PSE2	Innovative buildings and landscape [20], [1]	1-6
		PSE3	Tourist information boards [14].	1-6
		PSE4	Tourism waste management [21], [23].	1-6
3	Affective digital content	AC1	Positive reviews [24], [26].	1-6
		AC2	Content expectations [26], [43].	1-6
		AC3	Environment-related content [26], [27].	1-6
		AC4	Content facts [15]	1-6
4	Digital review ratings	RR1	Highest ratings [26], [29].	1-6
		RR2	Providing ratings and reviews [26], [28].	1-6
		RR3	Visit choice [30]	1-6
		RR4	Impression[4],[32].	1-6
5	Technology readiness	RD1	Availability of network connectivity at the destination tourism area (DTW) [18], [26].	1-6
		RD2	Availability of free Wi-Fi at the destination tourism area (DTW) [35], [31].	1-6
		RD3	Digital payment at the destination tourism area (DTW) [32], [33].	1-6
		RD4	Other services at the destination tourism area (DTW) [18], [34].	1-6
6	Digital tourist satisfaction	SAT1	Attraction information boards [36].	1-6
		SAT2	Social media information [39].	1-6
		SAT3	Information understanding [38].	1-6
		SAT4	Willingness to recommend	1-6
		SAT5	I will give good ratings and reviews [37]	1-6
		SAT6	Fair product prices [35], [32].	1-6

Source: Researchers

The data analysis technique used was crosstabulation testing, which is a descriptive cross-tabulation analysis to examine data across rows and columns. Crosstabulation was applied to analyze respondents' demographic data in this study. Before proceeding to the research data analysis model, the data were tested for feasibility. Subsequently, the research variables were examined using frequency analysis of questionnaire statements. This analysis was conducted using SPSS software version 16.

The next statistical data analysis technique employed the Structural Equation Model (SEM) using SmartPLS version 3.0 software. Prior to model testing, the data were assessed for feasibility to ensure optimal results in SEM analysis. In the final stage, hypotheses were tested using SmartPLS to determine the direct and indirect effects of each research variable and to assess whether the model could be applied effectively [50].

Data analysis & Interpretation

The leading potential of Karo Regency lies not only in its growth figures, but also in the creativity, tourism, and living culture embedded within its society. For example, the MSME sector in the creative economy and tourism has shown positive development, particularly through local products and community participation in events such as the Flower and Fruit Festival in Berastagi, which strengthens Karo's image as a tourism destination and a hub of local creativity [51]. The development of tourism in Karo through the utilization of geographic database systems indicates that information management and tourism promotion infrastructure are key driving factors in the growth of the tourism sector [52]. With a strong cultural foundation, rich natural potential, and government commitment to strategic planning, Karo is on the right path to becoming a successful model of inclusive and sustainable regional development.

Table 2. Top 10 Tourist Attractions in Karo Regency

No	Destination in Karo Regency	Destination in Karo Regency
1	Gunung Sibayak	121
2	Danau Lau Kawar	116
3	Air Terjun Sikulikap	105
4	Air Terjun Sipiso Piso	90
5	Kota Berastagi	58
6	Gundaling	25
7	Mikie Holiday Funland	19
8	Pemandian Air Panas Sidebuk-Debuk	50
9	Penatapan	13
10	Taman Alam Lumbini	8

Source: Author (2025)

In this study, the researchers ranked tourism destinations in Karo Regency based on visitor preference and intention to visit. Mount Sibayak ranked first, followed by Lake Lau Kawar. This indicates that highland nature-based tourism destinations contribute significantly to sustainable tourism development through unique landscapes, biodiversity, and distinct climatic experiences compared to lowland areas. Natural values—such as scenic beauty, biodiversity, and well-preserved ecosystems—are the main factors motivating tourists to choose nature-based destinations, making conservation an inseparable element of tourism development [53].

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Table 3. Integration of Main Tourism Destinations and Extended Destinations in Karo Regency

No	Advanced Destinations (Karo Integration)	Tourist Destination Area						Total
		Lake Toba (Tongging)	Mount Sibayak	Berastagi City	Sikulikap Waterfall	Sidebuk-Debuk Hot Springs	Lake Lau Kawar	
1	Air Terjun Sikulikap		47	14		36	8	105
2	Air Terjun Sipiso Piso	44	9	2	10	17	8	90
3	Bukit Gajah Bobok			1				1
4	Danau Lau Kawar	23	24	16	26	27		116
5	Gundaling	3	4	9	6	3		25
6	Gundaling Farmstead		1	3			2	6
7	Gunung Sibayak	8		10	34	53	16	121
8	Gunung Sibuaten			2	2	2	1	7
9	Gunung Sinabung	1	1	1				3
10	Hotel Bukit Kubu	1				2		3
11	Jembatan Kaca Gundaling	2				1		3
12	Kota Berastagi	9	9		9	8	23	58
13	Kebun Buah Berastagi			1				1
14	Mikie Holiday Funland		3	9	3		4	19
15	Paepira - Lake Toba			1				1
16	Pasar Buah Berastagi						1	1
17	Pemandian Air Panas Sidebuk-Debuk	18	6	19	2		5	50
18	Penatapan	2	3	4	1	2	1	13
19	Puncak 2000 Siosar	3					1	4
20	Sapo Juma	2				1		3
21	Sarune	3	1					4
22	Taman Simalem Resort		2		2			4
23	Tahura	4						4
24	Taman Alam Lumbini	3		2		3		8
25	Taman Mejuah-Juah						1	1
26	Taman Seribu Bunga Raya		2					2
27	Tongging	2			2		2	6
28	Tugu Perjuangan Berastagi	2						2
Total		130	112	94	97	155	73	661

Source: Author (2025)

The integration of travel between tourism objects in highland areas is crucial to ensure a cohesive visitor experience and to maximize the utilization of natural resources and infrastructure. This is reflected in the integrated data collection between primary tourism destinations and their extended destinations (tourism corridors). The development of inter-regional tourism corridors connecting multiple destinations through transportation networks and supporting facilities significantly improves visit efficiency, reduces travel time barriers, and expands the spatial attractiveness of tourism activities [54]. With integrated corridors, destinations located in remote or high-altitude areas become more accessible and included in tourist itineraries, increasing visitation while distributing economic benefits more evenly.

Beyond physical access and transportation, integration also involves the design of tourism routes that consider distance, travel time, experience diversity, and travel comfort. Tourism route planning should not merely connect destinations, but also optimize travel time and experience by selecting routes that minimize elevation gradients and consider public transportation options [55]. Such an approach provides more sustainable, comfortable, and marketable tourism routes, thereby enhancing visitor loyalty and adding value to highland destinations as a whole.Based on the data collected, the majority of respondents were men and women aged 21–30 years (42.7%), students (38%), and unmarried (62.8%). They generally traveled with friends (46.5%), searched for destination information through social media (56%), were willing to spend one day at the destination (39%), traveled 1–2 times per year (43%), used motorcycles (42%), and preferred nature-based

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tourism activities (91%). Contemporary young tourists rely heavily on social media as their primary source of information influencing destination perception, providing reviews, photos, and recommendations that directly affect travel decisions. Digital platforms and online reviews play a significant role in shaping destination reputation and guiding trip planning.

Furthermore, the motivation to travel with friends is closely linked to social interaction needs, where collective travel experiences enhance satisfaction by strengthening social bonds and adding meaning to tourism activities. Short-duration trips are increasingly popular among domestic tourists due to flexibility and ease of access, particularly for stress relief from routine activities. Short visit patterns are associated with destinations offering intensive experiences within limited timeframes, enabling satisfaction without long stays, as tourists adjust travel consumption patterns according to financial capacity while maintaining recreational needs [56]. Tourism expenditure is strongly related to household income levels; even low-income groups demonstrate willingness to allocate part of their income for travel experiences. Travel expenditure decisions are influenced by individual preferences for quality of life and psychological satisfaction, positioning tourism as an investment in social and emotional well-being [57].

Outer Model Testing

This study employs the Partial Least Squares (PLS) approach using SmartPLS 3.0 software. Partial Least Squares (PLS) is a variance-based Structural Equation Modeling (SEM) technique. PLS does not require specific distributional assumptions to estimate parameters; therefore, parametric techniques for significance evaluation are not required. Model evaluation in PLS is conducted through the assessment of the outer model and the inner model. Figure 1 presents the outer model used in this study, estimated using the PLS Algorithm.

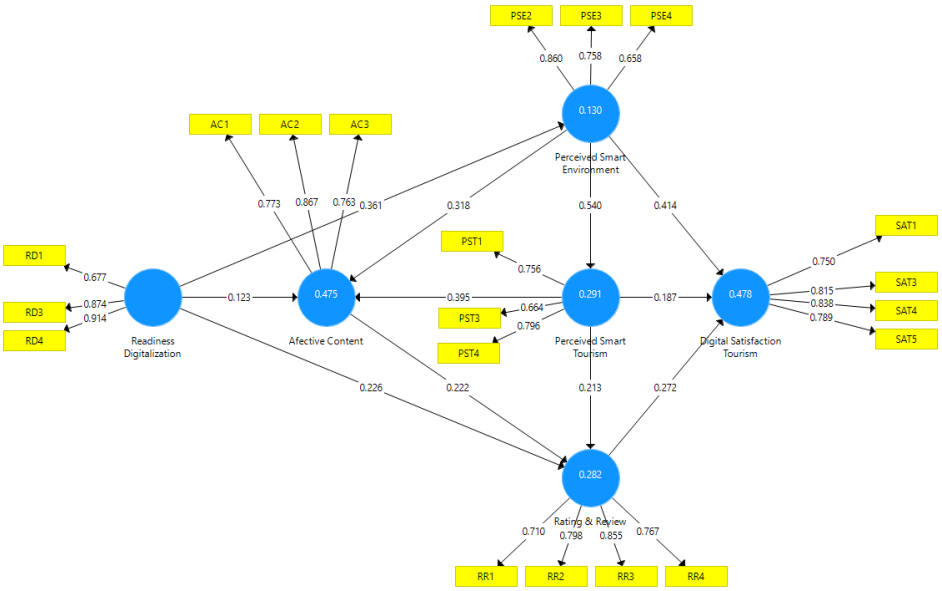

Figure 1. Outer Model (PLS Algorithm)

Source: Author (2025)

At this stage, the first test conducted is the feasibility test. The feasibility test is performed on the research data to determine whether the data can proceed to the data analysis stage and adequately represent the study optimally [58]. Validity testing in this study uses Convergent Validity from the Measurement Model with reflective indicators based on the correlation between item scores and their construct indicators. An individual indicator is considered valid if it has a value above 0.70. Several outer loading values between 0.5 and 0.7 are considered sufficient to meet the requirements of Convergent Validity [59].The validity testing for reflective indicators using the correlation between item scores and construct scores yielded good results, as all values were above 0.5. This indicates that all statement/question items in the study are valid and acceptable. In the validity test, the value of statement IN1 was removed because it had a value below 0.5. Furthermore, several outer loading values were retained because they still met the decision criteria, with three indicators (PSE3, PST3, RD1) having values between 0.5 and 0.7.Convergent validity refers to the extent to which a measure positively correlates with alternative measures of the same construct. Using the domain sampling model, indicators of a reflective construct are treated as different approaches (alternatives) to measuring the same construct. Therefore, items that serve as indicators (measures) of a specific reflective construct should converge or share a high proportion of variance. To evaluate convergent validity for reflective constructs, researchers consider indicator outer loadings and the Average Variance Extracted (AVE).

High outer loadings on a construct indicate that the associated indicators share substantial commonality, as reflected by the construct. The magnitude of the outer loading is also referred to as indicator reliability. At a minimum, the outer loadings of all indicators should be statistically significant. Because statistically significant outer loadings may still be weak, a commonly used rule of thumb is that standardized outer loadings should be 0.708 or higher. The rationale behind this rule can be understood by considering the squared standardized outer loading of an indicator, which represents the communality of an item. The squared standardized outer loading indicates the amount of variance in an item explained by the construct and is represented as the Average Variance Extracted (AVE) for that item. The established rule is that a latent variable should explain the majority of the variance of each indicator, typically at least 50%. This also implies that the variance shared between the construct and its indicator is greater than the variance due to measurement error. Therefore, an indicator's outer loading should be above 0.708 because the square of this value (0.708^2) equals 0.50. In practice, values close to 0.70 are generally considered acceptable [59].

Using the same logic applied to individual indicators, an AVE value of 0.50 or higher indicates that, on average, the construct explains more than half of the variance of its indicators [59]. Conversely, an AVE below 0.50 indicates that, on average, more variance remains in the item error than is explained by the construct. The AVE of each reflectively measured construct must be evaluated. This study passes the validity test using Average Variance Extracted (AVE), as the AVE value of each variable is greater than 0.5. AVE validity testing differs from outer loading testing, as AVE focuses on the construct, while outer loading focuses on individual item indicators in the model.

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Table 4. Construct Reliability and Validity

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Affective Content	**0,721**	0,722	0,844	**0,644**
Digital Satisfaction Tourism	**0,810**	0,813	0,875	**0,638**
Perceived Smart Environment	**0,638**	0,672	0,805	**0,582**
Perceived Smart Tourism	**0,586**	0,594	0,784	**0,549**
Rating & Review	**0,790**	0,799	0,864	**0,614**
Readiness Digitalization	**0,766**	0,821	0,866	**0,686**

Source: Author (2025)

The next feasibility test is the reliability test. Reliability testing examines the consistency of repeated observations in the study; a good study is one that passes the reliability test. Reliable data are indicated by a Cronbach's alpha value greater than 0.6. As shown in Table 4, all variables pass the reliability test because the Cronbach's alpha values for each variable (Affective Content, Digital Satisfaction Tourism, Perceived Smart Environment, Perceived Smart Tourism, Rating & Review, and Readiness Digitalization) are greater than 0.6 (>0.6).

Inner Model Evaluation

The evaluation of the structural model (inner model) using SmartPLS begins by examining the R Square values for each latent variable. The R Square value indicates the ability of the variables to explain the study and maintain the tested model.

The interpretation of the R Square values is as follows:

1. The R Square value for Affective Content is 0.475, indicating that the latent variables Digital Satisfaction Tourism, Perceived Smart Environment, Perceived Smart Tourism, Rating & Review, and Readiness Digitalization explain or predict 47.5% of Affective Content, while the remaining 52.5% is explained by other variables not included in this study.
2. The R Square value for Digital Satisfaction Tourism is 0.478, indicating that Affective Content, Perceived Smart Environment, Perceived Smart Tourism, Rating & Review, and Readiness Digitalization explain or predict 47.8% of Digital Satisfaction Tourism, while the remaining 52.2% is explained by other variables outside this study.
3. The R Square value for Perceived Smart Environment is 0.130, indicating that Digital Satisfaction Tourism, Affective Content, Perceived Smart Tourism, Rating & Review, and Readiness Digitalization explain or predict 13% of Perceived Smart Environment, while the remaining 87% is explained by other variables.
4. The R Square value for Perceived Smart Tourism is 0.291, indicating that Digital Satisfaction Tourism, Perceived Smart Environment, Affective Content, Rating & Review, and Readiness Digitalization explain or predict 29.1% of Perceived Smart Tourism, while the remaining 70.9% is explained by other variables.
5. The R Square value for Rating & Review is 0.282, indicating that Digital Satisfaction Tourism, Perceived Smart Environment, Perceived Smart Tourism, Affective Content, and Readiness Digitalization explain or predict 28.2% of Rating & Review, while the remaining 71.8% is explained by other variables.

Hypothesis Testing

Hypothesis testing in this study is conducted using the inner model by examining the total effect, which shows the parameter coefficients and t-values. The t-table value is 1.97 with 243 samples and 6 variables. In SmartPLS testing, statistical testing of each hypothesized relationship is conducted using simulation. The method applied is bootstrapping, as illustrated below.

The table of direct effect testing shows the influence and magnitude of direct effects among research variables, as presented in Table 5.

Table 5. Path Coefficients (Direct Effect)

No		Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
1	Affective Content -> Rating & Review	0,222	0,220	0,100	2,225	0,027
2	Perceived Smart Environment -> Affective Content	0,318	0,317	0,068	4,655	0,000
3	Perceived Smart Environment -> Digital Satisfaction Tourism	0,414	0,410	0,082	5,072	0,000
4	Perceived Smart Environment -> Perceived Smart Tourism	0,540	0,546	0,053	10,136	0,000
5	Perceived Smart Tourism -> Affective Content	0,395	0,396	0,072	5,475	0,000
6	Perceived Smart Tourism -> Digital Satisfaction Tourism	0,187	0,187	0,079	2,364	0,018
7	Perceived Smart Tourism -> Rating & Review	0,213	0,220	0,093	2,300	0,022
8	Rating & Review -> Digital Satisfaction Tourism	0,272	0,278	0,071	3,833	0,000
9	Readiness Digitalization -> Affective Content	0,123	0,124	0,063	1,968	0,050
10	Readiness Digitalization -> Perceived Smart Environment	0,361	0,362	0,065	5,550	0,000
11	Readiness Digitalization -> Rating & Review	0,226	0,225	0,072	3,119	0,002

Source: Author (2025)

Based on the table above, with T-statistics values > 1.97 and P-values < 0.05, the decision regarding the direct effects among variables is as follows.

The discussion in this study aims to examine both the direct and indirect effects among latent variables. Based on the statistical analysis, the

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relationships among the research variables are explained as follows:

1. Effect of Affective Content on Rating & Review

The Affective Content variable has a positive and significant direct effect on the Rating & Review variable at tourist attractions in Karo Regency. Affective content refers to the emotional elements embedded in content viewed or read by tourists (e.g., promotional videos, vlogs, or multimedia-based reviews). This content directly influences ratings and reviews because affective cues modulate tourists' evaluative judgments.

These findings indicate that the affective dimension of content functions as a direct signal of satisfaction or dissatisfaction and thus serves as a direct predictor of both quantitative evaluations (ratings) and the narrative quality of reviews [60].

Structurally, exposure to content that evokes affective responses shapes the affective image of a destination at the cognitive–affective level, which subsequently influences evaluative intentions and review-writing behavior. Emotions and cognition generated through consuming reviews affect destination image, recommendation intentions, and directly link affective content to ratings and reviews in Karo Regency. Local-language user-generated content (UGC), affective score extraction, platform algorithms, and reviewer characteristics confirm the strength of this relationship in Karo Regency [61].

2. Effect of Perceived Smart Environment on Affective Content

The Perceived Smart Environment variable has a positive and significant direct effect on Affective Content at tourist attractions in Karo Regency. Perceived smart environment refers to tourists' perceptions of smart technological attributes at destinations (e.g., informativeness, accessibility, interactivity, personalization, and security). These attributes influence affective content through direct changes in visitors' emotional experiences.

Smart infrastructure and services provide timely and interactive informational stimuli, reduce uncertainty, and facilitate sensory engagement (e.g., AR/VR, digital guides, real-time location information). Visitors' affective responses—such as emotional attachment, arousal, and awe—are formed through these stimuli and are subsequently expressed in the affective content they produce or consume (e.g., emotionally rich narratives in reviews, reaction videos, or photos with emotional captions). Perceived smart environments and experience quality/well-being are closely associated with the affective components of tourist experiences [62].

By enhancing perceived experiences and visitor satisfaction, which are theoretically and empirically linked to increased emotional intensity (positive or negative), these emotions are reflected in affective content such as emotionally toned reviews or audiovisual materials. Since affective content represents visitors' subjective emotional experiences, perceptions of smart environment elements shape memorable experiences and well-being, supporting the argument that language use, visitor characteristics, and the type of technology implemented influence affective content formation [63].

3. Effect of Perceived Smart Environment on Digital Satisfaction Tourism

The Perceived Smart Environment variable has a positive and significant direct effect on Digital Satisfaction Tourism at tourist attractions in Karo Regency. In tourism contexts, perceived smart environment refers to the extent to which tourists perceive the presence of smart technologies that support comfort, interactivity, and ease of access to information. Positive perceptions of smart environments enhance digital satisfaction tourism, defined as tourists' satisfaction with digital-based experiences derived from real-time information availability, online services, and technology-based facilities at destinations.

Smart tourism technologies—such as mobile applications, interactive services, and intelligent information systems—significantly influence tourist experiences and satisfaction by minimizing travel barriers and enriching destination experiences [62].

The use of smart technologies in tourism positively affects tourist well-being and satisfaction, primarily through ease of information access, increased convenience, and enhanced interactivity. These findings are particularly relevant for tourist destinations in Karo Regency, which have significant potential to integrate digital technologies into destination management. By providing positively perceived smart environments—such as regional tourism applications, digital maps, or automated services—destination managers can enhance tourists' digital satisfaction, ultimately encouraging loyalty, revisit intentions, and online word-of-mouth promotion.

4. Effect of Perceived Smart Environment on Perceived Smart Tourism

The Perceived Smart Environment variable has a positive and significant direct effect on Perceived Smart Tourism at tourist attractions in Karo Regency. Theoretically, when visitors perceive the environment as "smart" (e.g., informative guide applications, convenient digital payment facilities, interactive on-site services), their perceived usefulness and ease of use increase. These perceptions are core components of the perceived smart tourism construct, which integrates experiential, value-based, and behavioral intention aspects.

Empirical evidence suggests that accessibility and interactivity dimensions of smart technologies enhance tourists' perceived smart tourism experiences. In Karo Regency, the development of smart environment elements such as improved informativeness (local digital maps, scheduling information), interactivity (AR/QR-based guides), and service personalization is expected to increase tourists' perceived smart tourism evaluations.

5. Effect of Perceived Smart Tourism on Affective Content

The Perceived Smart Tourism variable has a positive and significant direct effect on Affective Content at tourist attractions in Karo Regency. Smart tourism emphasizes experience quality enhancement as the primary objective of technology implementation. Informative and interactive technologies reduce uncertainty, facilitate tourist engagement, and enhance experience memorability, thereby increasing the valence and intensity of tourists' emotions. These emotions subsequently serve as the primary material for the production of affective content at tourist destinations in Karo Regency [64].

6. Effect of Perceived Smart Tourism on Digital Satisfaction Tourism

The Perceived Smart Tourism variable has a positive and significant direct effect on Digital Satisfaction Tourism at tourist attractions in Karo Regency. When tourists perceive digital features as useful and easy to use, informational and transactional barriers are reduced, making information searching, location navigation, and service interactions more efficient. This increased utility and ease directly enhance satisfaction with the digital aspects of tourism experiences.

Additionally, interactivity and personalization dimensions enrich visitor engagement and increase the likelihood of memorable digital experiences—factors known to strengthen emotional and cognitive satisfaction evaluations. Thus, perceived smart tourism serves as a key determinant of tourists' positive evaluations of digital services and facilities at destinations in Karo Regency.

7. Effect of Perceived Smart Tourism on Rating & Review

The Perceived Smart Tourism variable has a positive and significant direct effect on Rating & Review at tourist attractions in Karo Regency. When tourists evaluate smart tourism services—such as real-time information availability, online reservation systems, digital maps, cashless payments, and application-based interactivity as effective, accurate, and user-friendly, these positive perceptions are reflected in their final evaluations.

This finding aligns with the technology acceptance and expectation-confirmation models, which suggest that satisfaction with

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technology-based services increases tourists' propensity to provide positive ratings and supportive reviews. Consequently, perceived smart tourism quality functions as a catalyst for improved digital evaluations of destinations. Positive reviews not only serve as feedback but also act as a form of digital reputation that influences potential tourists, thereby strengthening destination competitiveness.

8. Effect of Rating & Review on Digital Satisfaction Tourism

The Rating & Review variable has a positive and significant direct effect on Digital Satisfaction Tourism at tourist attractions in Karo Regency. Online reviews function as social validation that influences perceived experience quality. When tourists read high ratings or positive reviews aligned with their needs, their expectations increase, leading to higher satisfaction when actual experiences meet or exceed expectations.

Moreover, ratings and reviews reflect previous tourists' experiences, reinforcing trust and digital connectedness with destinations. Tourists who encounter detailed narratives, photos, or practical recommendations in reviews feel more supported during their journeys, enhancing their digital experience satisfaction. Two-way interactions through reviews further create a sense of appreciation and strengthen satisfaction.

9. Effect of Readiness Digitalization on Perceived Smart Environment

The Readiness Digitalization variable has a positive and significant direct effect on Perceived Smart Environment at tourist attractions in Karo Regency. Digital readiness includes supporting infrastructure such as stable internet networks, information sensors, interactive devices, and real-time accessible application-based systems.

Low technological readiness such as weak internet connectivity or non-functional destination applications results in low perceptions of smart environments. Conversely, well-designed technological infrastructure enables easier information access, service interaction, and efficient experiences, thereby enhancing positive perceptions of smart environments. Digital readiness not only concerns hardware and network provision but also the integration of information systems relevant to tourists' needs in Karo Regency.

10. Effect of Readiness Digitalization on Rating & Review

The Readiness Digitalization variable has a positive and significant direct effect on Rating & Review at tourist attractions in Karo Regency. When digital infrastructure and services are reliable, visitors can easily access real-time information, conduct cashless transactions, and utilize interactive features (QR/AR/digital maps), reducing cognitive and operational barriers and creating smoother experiences.

Ratings and reviews represent electronic word-of-mouth (eWOM), which is highly sensitive to experience quality. In rural destinations, technological readiness can be viewed as an initial driver of improved experiences and satisfaction, influencing both the direction and intensity of ratings and reviews [65]. Digital readiness also moderates tourists' evaluative behaviors in writing reviews. In travel services, individual digital readiness has been shown to significantly shape satisfaction with travel technologies and subsequent evaluative behaviors [66].

Predictive Relevance (Q^2)

Predictive relevance refers to a model's ability to predict future observation values based on historical data. A model with predictive relevance can be applied as part of future problem-solving strategies. To assess predictive capability, this study uses Construct Cross-Validated Redundancy by examining Q^2 values.

Table 7. Construct Cross-Validated Redundancy

	SSO	SSE	Q^2 (=1-SSE/SSO)
Affective Content	729,000	515,652	0,293
Digital Satisfaction Tourism	972,000	691,457	0,289
Perceived Smart Environment	729,000	679,451	0,068
Perceived Smart Tourism	729,000	617,420	0,153
Rating & Review	972,000	812,702	0,164
Readiness Digitalization	729,000	729,000	

Source: Author (2025)

A Q^2 value greater than 0 indicates that the model has predictive relevance for specific endogenous constructs. Conversely, values of 0 or below indicate a lack of predictive relevance [59]. In this study, all Q^2 values are greater than 0, indicating that the model possesses predictive relevance.

The cross-validated communality approach measures a model's ability to directly predict indicators from their antecedents using cross-validation within the measurement model [67]. In determining Q^2 values, the Construct Cross-Validated Redundancy approach is based on predictions derived from both the structural model (antecedent construct scores) and the measurement model (target endogenous constructs). An alternative method, the Construct Cross-Validated Communality approach, uses only the estimated construct scores for the target endogenous constructs (without incorporating information from the structural model) to predict omitted data points. Therefore, prediction using cross-validated redundancy is highly appropriate for the PLS-SEM approach.

Research Findings on Tourist Satisfaction in Nature-Based Tourism

The findings of this study, derived from interviews and field data analysis, identify key factors influencing tourist satisfaction in nature-based tourism. The main factors include:

1. Service quality, including staff friendliness, service speed, accommodation comfort, and professionalism of tourism service providers;
2. Price fairness, referring to the alignment between costs incurred and experiences obtained, including transportation, entrance fees, and accommodation;
3. Facilities and infrastructure, such as the availability of public toilets, parking areas, transportation, accessibility, and supporting facilities including restaurants or information centers;
4. Cleanliness and safety, as clean, well-maintained, and secure environments strongly influence tourists' perceptions;
5. Destination attractions, encompassing natural uniqueness, cultural offerings, culinary experiences, and recreational activities;
6. Social and emotional experiences, including interactions with local communities, travel companions, and the overall atmosphere experienced;
7. Technological readiness (Readiness Digitalization), referring to ease of accessing information, digital reviews, and social media, which strengthen experiences before, during, and after visits.

Recent studies also emphasize that tourist satisfaction is not the result of a single factor, but rather a holistic combination of

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experiences. Given the digital focus of this study, factors influencing digital tourist satisfaction are closely related to technology-supported tourism experiences before, during, and after travel. The key factors include:

1. Digital information quality, referring to the accuracy, completeness, and ease of accessing destination information through websites, applications, or social media;
2. Usability and accessibility of digital platforms, including simple, fast, and multi-device-accessible application or website designs;
3. Online transaction security, ensuring safe, transparent, and reliable digital payment systems for booking tickets, accommodations, and tourism packages;
4. Connectivity, including internet access, Wi-Fi availability, and supporting digital infrastructure at tourism destinations;
5. Interactivity and personalization, reflecting platforms' ability to provide recommendations aligned with tourists' preferences and offer direct communication features such as chatbots, reviews, and ratings;
6. Digital content and online reviews, including photos, videos, and testimonials from other tourists that shape perceptions and expectations prior to visits;
7. Experience technology integration, such as the use of immersive technologies (AR/VR), e-guides, and interactive digital maps that enrich tourism experiences.

Digital tourist satisfaction emphasizes the role of digital experience quality delivered through social media and mobile applications in shaping satisfaction [68]. Ease of access to information, online reviews, and digital services influences tourists' intentions to revisit and recommend destinations [69].

When tourist satisfaction is viewed from the perspective of tourism branding satisfaction, successful destination branding enhances satisfaction by shaping clearer perceptions of experience quality and uniqueness. Destination brand image and tourists' emotional experiences significantly influence long-term satisfaction and loyalty [70]. Accordingly, key influencing factors include:

1. Destination image, referring to tourists' perceptions of destination uniqueness, attractiveness, and reputation, which build higher expectations and satisfaction;
2. Brand identity quality, indicating the extent to which destination logos, slogans, or symbols are easily recognized and consistently promoted;
3. Brand equity, reflecting tourists' trust in the destination brand, including awareness, associations, loyalty, and perceived quality;
4. Brand experience, representing the extent to which tourists experience the promises communicated through branding, such as local hospitality, natural beauty, or modern facilities;
5. Expectation–reality congruence, where branding success depends on a destination's ability to fulfill promotional promises;
6. Digital and offline word of mouth, including reviews, testimonials, and recommendations that strengthen destination brand reputation.

Affective content that resonates emotionally with audiences—such as empathy, closeness, and personal values—enhances user engagement. When audiences feel emotionally connected, they are more likely to like, comment on, and share content, thereby directly increasing the engagement rate as an indicator of digital communication effectiveness

Table 8. Engagement Rate Levels

No	Engagement Rate Level	Engagement Rate Level	Engagement Rate Level
1	Very Low	< 1%	Passive audience, very minimal interaction, content is less relevant
2	Low	1% – 2%	Limited engagement, content strategy needs optimization
3	Moderate / Fair	2% – 4%	Engagement begins to form, common for small–medium business accounts
4	Good	4% – 6%	Active audience, relevant content, and trust-building

Source: Author (2025)

To calculate engagement rate (ER), researchers must first determine the appropriate ER formula based on content interactions such as likes, comments, shares, saves, views, clicks, mentions, tags, ratings, and reviews.

Table 9. Engagement Rate Formulas

Formula Type	Formula	Pros	Cons
Engagement Rate by Reach (ERR)	ERR = (Total engagements / Reach) × 100	More accurate in the algorithm era, accounts for non-followers	Reach fluctuates; low reach can distort results upward and vice versa
Engagement Rate by Post (ER post)	ER post = (Total engagements / Total followers) × 100	Stable for post-by-post comparison, commonly used by influencers	Does not account for viral reach; engagement rate may decrease as followers increase
Engagement Rate by Impressions (ER impressions)	ER impressions = (Total engagements / Total impressions) × 100	Effective for paid content, especially CPM-based cost structures	Lower rates due to repeated impressions; less consistent than reach
Daily Engagement Rate (Daily ER)	Daily ER = (Total daily engagements / Total	Measures daily interaction, including engagement on older content; adjustable	Prone to inaccuracies, does not account for repeated engagement by the same followers, varies with posting

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	followers) × 100		frequency
Engagement Rate by Views (ER views)	ER views = (Total engagements on video posts / Total video views) × 100	Tracks engagement for video content with engagement-oriented goals	Repeated views may inflate numbers; low likelihood of repeated engagement
Cost per Engagement (CPE)	CPE = Total amount spent / Total engagements	Useful for influencer marketing and conversion-based campaigns; often calculated by platforms	Ensure engagement definitions are consistent for comparison

Conclusion

This study shows that all variables have a significant direct effect.
Specifically:

1. Digitalization Readiness plays an important role in enhancing tourists' perceptions of the smart environment and in encouraging positive ratings and reviews.
2. Perceived Smart Environment and Perceived Smart Tourism contribute to the formation of affective content and tourists' digital satisfaction.
3. Affective Content is closely associated with ratings and reviews, which in turn increase tourists' digital satisfaction.
4. Young tourists with limited spending dominate visits to nature-based tourism destinations, using social media as their primary source of information and digital reviews.
5. Therefore, an effective digital marketing model for Karo tourism should integrate technological readiness, emotional digital content, and online review systems to enhance tourist satisfaction.

Theoretical Implications

Strengthening the Smart Tourism Model confirms that smart environment and smart tourism are not merely technological factors, but also psychological elements that shape tourists' emotional experiences. This expands smart tourism ecosystem theory by adding an affective dimension in influencing tourist behavior. The contribution of eWOM (electronic Word of Mouth) as affective content plays a significant role in shaping ratings and reviews. These findings enrich eWOM theory by demonstrating how the emotional content of digital media can directly alter tourists' quantitative evaluations, as well as extending digital satisfaction theory: tourist satisfaction is influenced not only by physical services, but also by the quality of digital experiences. This provides a basis for integrating customer satisfaction theory with digital technology–based variables. Furthermore, this study shows that the Technology Acceptance Model (TAM) can be extended with an emotional (affective) dimension, where acceptance of tourism technology is not only rational, but also influenced by tourists' emotional experiences.

Research Limitations

The research location focused only on six main destinations in Karo Regency; therefore, the results may not be generalizable to all tourist destinations in Indonesia. Respondent characteristics were dominated by young tourists with low-to-middle income levels, limiting the representation of other tourist groups such as international tourists or high-income tourists. The study employed only six main variables; other external factors such as government policies, cultural factors, or broader physical infrastructure conditions were not included. The research design used a cross-sectional approach (single time period), which does not capture changes in tourists' perceptions over time. In addition, digital data were mainly based on respondents' questionnaire perceptions and did not deeply explore secondary data from digital platforms (e.g., big data from Google or TripAdvisor reviews).

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